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Socio-economic inequalities in oral health among Portuguese older adults: a cross-sectional study

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Abstract

Background Although the oral health status has improved in developed countries in recent years, oral diseases are still unequally distributed across socio-economic groups. Research on the impact of socio-economic factors on oral health care among older adults in Europe, including Portugal, remains limited. The main aim of this study was to investigate the association between socio-economic factors and oral health indicators in Portuguese older adults.

Methods This retrospective cross-sectional study analyzed data from 915 participants (aged 65 years and older) from the third wave (2015–2016) of the Epidemiology of Chronic Diseases Cohort Study (EpiDoC), a population-based study. Socio-economic and demographic information, general health-related characteristics and oral health data (prosthetic need, oral hygiene frequency, and last dental procedure) were collected by questionnaire. Multivariate logistic and multinomial regression models analyzed the associations between socio-economic factors and oral health indicators.

Results Participants with lower education level, perceived lower income and a fewer number of private sector appointments were more likely to have poor oral health (need for prosthetic treatment, less frequent oral hygiene, and tooth extraction as last dental procedure). Other factors found to be associated with oral health were sex, age, geographical area, smoking habits, and body mass index.

Conclusions Socio-economic factors were associated with oral health in Portuguese older adults. These findings may contribute to future national public health strategies by expanding oral health services to ensure better access and coverage for at-risk groups.

Keywords Oral health, Older, Socio-economic factor, Socio-economic inequality

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Background

The number of older people worldwide has been increasing over the last few decades and is expected to continue to grow in the future. By 2050, the number of people in the world aged 60 and over will have doubled [1]. In the Portuguese context, according to the latest data evaluated in 2021, older adults represent 23.4% of the total population [2]. Addressing the needs of this age group, particularly in terms of health care, is therefore a priority [1–3].

According to recent reports, oral health is a critical and often neglected area of healthy ageing that requires increased attention [1, 3]. The most common oral conditions in older adults are untreated caries, periodontal disease, tooth loss, xerostomia, and precancerous or cancerous conditions of the oral cavity [4]. In addition, there is strong evidence of a link between oral and systemic health, with oral diseases being associated with diabetes, musculoskeletal, cardiovascular, cerebrovascular, and respiratory diseases. This highlights the importance of regular use of oral health services by older adults for oral diseases prevention and early treatment of identified problems [3, 5].

Although the oral health status has improved in developed countries in recent years, oral diseases are still unequally distributed across socio-economic groups [6]. In addition, socio-economic inequalities in access to oral health services are often more pronounced than for general health services. Socio-economic factors such as educational attainment and household income are important determinants of oral health, as the literature reports that oral health progressively deteriorates from higher to lower socio-economic status [7–12]. The inclusion of oral health care in public health insurance packages has shown potential to reduce these disparities, although this practice is not yet widespread [13–15].

In Portugal, although efforts have been made to expand public coverage through the Portuguese Oral Health Programme launched in 2005, oral health services provided by the National Health Services, including public hospitals and health centers, are still limited and may have contributed to the poor oral health care of older individuals. Moreover, the fact that oral health services are predominantly provided in the private sector, mainly paid for out-of-pocket or by private health insurance, further exacerbates these challenges [16, 17].

Research on the impact of socio-economic factors on the oral health care of older adults in Europe, including Portugal, remains limited. To the best of our knowledge, there are no studies in Portugal that focus exclusively on the socio-economic aspects of oral health in older adults, a vulnerable group that requires special attention. Conducting comprehensive studies is crucial to identify the main determinants of access to health care and to define policies aimed at minimizing inequalities [10, 14, 18]. Therefore, the main purpose of the present study was to investigate the association between socio-economic factors and oral health indicators in Portuguese older adults. Secondarily, we intended to associate some general health-related characteristics with oral health.

Methods

Study design and participants

This retrospective cross-sectional study was integrated into the Epidemiology of Chronic Diseases Cohort Study (EpiDoC), a population-based study designed to investigate health determinants and outcomes, chronic non-communicable diseases, and their impact on health resource consumption. The EpiDoC cohort enrolled non-institutionalized adults (≥18 years old) living in mainland Portugal and its islands, who were willing and able to communicate, understand, and sign informed consent. Recruitment was stratified by regional socio-demographic characteristics to ensure that the sample was representative of the national population. Thus, the EpiDoC study included a sample of 10,661 individuals, representative of the adult Portuguese population since 2011, who answered to a structured questionnaire in a face-to-face interview by trained research assistants at baseline, signed the informed consent for follow-up, and provided their telephone number to be contacted in the subsequent follow-up evaluations (EpiDoC 2 and EpiDoC 3) [19, 20].

Data for this study were collected as part of EpiDoC 3, which was conducted between 1st September 2015 and 28th July 2016 and included 5,653 participants, representing 55.7% of those included in the first wave. Of these, individuals ≥65 years of age were selected for the current study ($n=915$) and answered a semi-structured questionnaire by telephone. This study followed the Strengthening Reporting of Observational Studies in Epidemiology (STROBE) guidelines [21].

Data colletion

Socio-economic and demographic characteristics

Socio-economic and demographic data were collected in EpiDoC 1 and confirmed in the follow-up waves. Some variables were converted into categorical variables (age and education level), and some were recategorized (marital status and employment status) in order to organize the data and ensure optimal interpretation.

The questionnaire included information regarding sex (female; male), age (then converted into age groups: 65–74; 75–84; ≥85 years), education level (≤4 years; 5–9 years; ≥10 years) and region of residence (according to the Nomenclature of Territorial Units for Statistics – NUTS II: North, Centre, Lisbon, Alentejo, Algarve, and Islands: Azores and Madeira). Other variables included

marital status, categorized as "with partner" (married or consensual union) or "without partner" (single, divorced, or widowed), employment status (retired or other—employed, unemployed), income perceptions ("Which of the following best describes your current feelings about your household income? Living comfortably with the present income; Living with the present income; Finding it difficult to live with the present income; Finding it very difficult to live with the present income") and the number of appointments in the private or public sector in the previous year.

From these variables, we consider education level, income perception, and the number of private sector appointments as the main exposures evaluated in our study.

General health-related characteristics

Smoking habits were collected and classified according to a semi-quantitative scale: never smoked, past smoker, or current smoker (occasionally/daily). Then, self-reported height and weight were collected, and body mass index (BMI) was calculated and categorized according to the nutritional status as < 18.49 kg/m^2 (underweight), 18.50–24.99 kg/m^2 (healthy weight) and ≥ 25.00 kg/m^2 (overweight) [22]. Finally, information on diagnosed diabetes was also collected using a dichotomous variable (yes/no).

Oral health indicators (Dependent variables)

The EpiDoC 3 study included self-reported oral health questions, such as prosthetic needs in edentulous areas (yes/no), oral hygiene frequency (specifically, tooth brushing) (< 2x/day/≥ 2x/day) and last dental procedure (routine; tooth extraction; other treatment). We considered participants to have "poor oral health" if they needed prosthetic treatment, brushed their teeth less than twice a day, or if their last dental procedure was a tooth extraction, as these factors have already been described in other studies as risk indicators of poor oral health [13, 23, 24].

Data analysis

We performed a descriptive analysis of the study sample for socio-economic, demographic factors and general health characteristics, considering oral health indicators (prosthetic needs, frequency of oral hygiene and last dental procedure). Categorical variables were presented as absolute and relative frequencies, and continuous variables as mean and standard deviation (SD). Independence hypotheses were tested to compare groups with oral health indicators according to their socio-economic, demographic, and general health-related characteristics using non-parametric tests. Categorical variables were compared using Chi-squared tests, while continuous variables were compared using Kruskal–Wallis tests due to the non-normality of the distribution of observations within groups.

Finally, three socio-economic factors that are often related (education level, income perception and number of private sector appointments attended) were analyzed separately to understand the individual association of each with oral health indicators [10, 11, 14]. Logistic regression models were calculated to assess the association between these three socio-economic factors and oral health data. A multinomial approach was used for outcomes with more than two categories. Two models were then constructed, model 1 adjusted for sex and age (as these were possible confounders), and model 2, using a forward selection method, comparing the models using likelihood ratio tests, further including statistically significant variables ($p \leq 0.25$) to avoid premature exclusion of potentially important variables [25]. At the end of this process, only smoking habits and BMI were included as further adjustments in model 2. For the last dental procedure, only model 1 was considered as there was no literature evidence to support further adjustment. Odds ratio (OR) and relative risk ratio (RRR) were estimated for each variable with a 95% confidence interval (95% CI). Missing data for the independent variables were less than 15%, so imputation methods were not used. The results were analyzed in terms of "poor oral health", defined as the need for prosthetic treatment, oral hygiene frequency less than twice a day or the last dental procedure being a tooth extraction. All analyses were performed using STATA® v17 (StataCorp: College Station, Texas, TX, USA: StataCorp LP), considering a significance level of 0.05.

Results

The mean age of the 915 participants was 74.3 (± 6.7) years. Female participants represented 63.1%) of the sample. The socio-economic, demographic and general health characteristics of the study participants in relation to the oral health variables are shown in Table 1.

Univariate analysis showed that the sex of the participants was associated with oral health outcomes, specifically prosthetic need ($p < 0.001$) and oral hygiene frequency ($p < 0.001$) with women presenting higher frequencies for no prosthetic need and better oral hygiene frequency. Higher age was significantly associated with less frequent oral hygiene and with tooth extraction as the last dental procedure ($p = 0.034$ and $p = 0.026$, respectively). Region of residence (NUTS II) had a significant association with oral hygiene frequency ($p < 0.001$), and the highest proportion of participants with more frequent oral hygiene were from Lisbon ($n = 140$, 25.2%). However, marital status and employment status did not show a significant association with oral health variables ($p > 0.05$).

Table 1 Socio-economic, demographic, and general health-related characteristics of participants according to oral health variables

	Total sample $n_{max}=915$	Prosthetic needs, n (%) $n=736$			Oral hygiene frequency, n (%) $n=906$			Last dental procedure, n (%) $n=439$			
		Yes	No	*p*-value[a]	< 2x/day	≥ 2x/day	*p*-value[a]	Routine	Tooth extraction	Other	*p*-value[a]
		169 (23.0%)	567 (77.0%)		351 (38.7%)	555 (61.3%)		176 (40.1%)	176 (40.1%)	87 (19.8%)	
Sex, n (%)				**< 0.001**			**< 0.001**				0.478
Male	338 (36.9%)	76 (45.0%)	169 (29.8%)		158 (45.0%)	175 (31.5%)		63 (35.8%)	72 (40.9%)	37 (42.5%)	
Female	577 (63.1%)	93 (55.0%)	398 (70.2%)		193 (55.0%)	380 (68.5%)		113 (64.2%)	104 (59.1%)	50 (57.5%)	
Age Group (years)				0.287			**0.034**				**0.026**
Mean (SD)	74.3 (±6.7)	73.5 (±6.7)	74.8 (±6.6)		74.9 (±7.0)	73.9 (±6.3)		71.9 (±5.6)	73.9 (±6.7)	71.9 (±5.4)	
65–74	501 (54.8%)	99 (58.6%)	293 (51.7%)		180 (51.3%)	316 (56.9%)		128 (72.7%)	103 (58.5%)	62 (71.3%)	
75–84	339 (37.1%)	58 (34.3%)	226 (39.9%)		133 (37.9%)	204 (36.8%)		40 (22.7%)	58 (33.0%)	23 (26.4%)	
≥85	75 (8.2%)	12 (7.1%)	48 (8.5%)		38 (10.8%)	35 (6.3%)		8 (4.6%)	15 (8.5%)	2 (2.3%)	
Region (NUTS II), n (%)				0.240			**< 0.001**				0.109
North	246 (26.9%)	49 (29.0%)	141 (24.9%)		113 (32.2%)	128 (23.1%)		45 (25.6%)	56 (31.8%)	22 (25.3%)	
Centre	208 (22.7%)	39 (23.1%)	125 (22.1%)		96 (27.4%)	112 (20.2%)		26 (14.8%)	41 (23.3%)	23 (26.4%)	
Lisbon	197 (21.5%)	29 (17.2%)	128 (22.6%)		54 (15.4%)	140 (25.2%)		51 (29.0%)	31 (17.6%)	22 (25.3%)	
Alentejo	69 (7.5%)	18 (10.7%)	40 (7.1%)		31 (8.8%)	38 (6.9%)		7 (4.0%)	10 (5.7%)	5 (5.8%)	
Algarve	41 (4.5%)	5 (3.0%)	32 (5.6%)		11 (3.1%)	30 (5.4%)		6 (3.4%)	8 (4.6%)	2 (2.3%)	
Islands	154 (16.8%)	29 (17.2%)	101 (17.8%)		46 (13.1%)	107 (19.3%)		41 (23.3%)	30 (17.1%)	13 (14.9%)	
Marital status, n (%)				0.676			0.067				0.067
With partner	549 (60.0%)	102 (60.4%)	332 (58.6%)		224 (63.8%)	319 (57.7%)		108 (61.4%)	112 (63.6%)	65 (75.6%)	
Employment status, n (%)				0.515			0.631				0.410
Retired	789 (86.7%)	148 (88.1%)	485 (86.1%)		301 (86.0%)	480 (87.1%)		155 (88.6%)	149 (84.7%)	78 (89.7%)	
Other	121 (13.3%)	20 (11.9%)	78 (13.9%)		49 (14.0%)	71 (12.9%)		20 (11.4%)	27 (15.3%)	9 (10.3%)	
Education level, n (%)				0.114			**< 0.001**				**< 0.001**
≥10 years	99 (10.8**%)**	16 (9.5%)	63 (11.1%)		18 (5.1%)	80 (14.4%)		38 (21.6%)	9 (5.1%)	14 (16.1%)	
5–9 years	140 (15.3%)	18 (10.7%)	94 (16.6%)		40 (11.4%)	98 (17.7%)		34 (19.3%)	24 (13.6%)	21 (24.1	
≤4 years	676 (73.9%)	135 (79.9%)	410 (72.3%)		293 (83.5%)	377 (67.9%)		104 (59.1%)	143 (81.2%)	52 (59.8%)	
Income perception, n (%)				**0.030**			0.120				**< 0.001**
"Living comfortably with the present income"	106 (11.6%)	13 (7.7%)	77 (13.6%)		31 (8.8%)	74 (13.4%)		34 (19.3%)	12 (6.8%)	11 (12.8%)	
"Living with the present income"	394 (43.2%)	65 (38.7%)	233 (41.2%)		145 (41.3%)	244 (44.2%)		100 (56.8%)	72 (40.9%)	32 (37.2%)	
"Finding difficult with the present income"	278 (30.5%)	55 (32.7%)	174 (30.8%)		118 (33.6%)	159 (28.8%)		25 (14.2%)	61 (34.7%)	33 (38.4%)	
"Finding it very difficult with the present income"	125 (13.7%)	35 (20.8%)	75 (13.3%)		54 (15.4%)	69 (12.5%)		15 (8.5%)	30 (17.1%)	10 (11.6%)	
Number of private sector appointments, Mean (SD)	1.26 (±2.88)	0.81 (±2.02)	1.41 (±3.11)	**0.009**	0.82 (±2.24)	1.52 (±3.18)	**< 0.001**	2.03 (±3.18)	0.86 (±2.26)	1.83 (±4.45)	**< 0.001**

Table 1 (continued)

	Total sample $n_{max}=915$	Prosthetic needs, n (%) $n=736$			Oral hygiene frequency, n (%) $n=906$			Last dental procedure, n (%) $n=439$			
		Yes	No	*p*-value[a]	< 2x/day	≥ 2x/day	*p*-value[a]	Routine	Tooth extraction	Other	*p*-value[a]
Number of public sector appointments, Mean (SD)	4.29 (±4.37)	4.74 (±4.05)	4.43 (±4.75)	0.086	4.45 (±4.22)	4.21 (±4.48)	**0.039**	3.61 (±4.05)	4.47 (±3.26)	4.65 (±5.20)	**<0.001**
Smoking habits, n (%)				**0.023**			0.858				0.908
Never	652 (72.0%)	109 (65.7%)	424 (75.6%)		253 (72.5%)	393 (71.8%)		123 (70.3%)	124 (71.3%)	61 (70.1%)	
In the past	210 (23.2%)	45 (27.1%)	116 (20.7%)		78 (22.3%)	129 (23.6%)		44 (25.1%)	40 (23.0%)	23 (26.4%)	
Daily/Occasionally	43 (4.8%)	12 (7.2%)	21 (3.7%)		18 (5.2%)	25 (4.6%)		8 (4.6%)	10 (5.7%)	3 (3.5%)	
BMI (Kg/m^2), n (%)				0.733			**0.006**				0.583
Underweight	59 (7.6%)	12 (8.4%)	36 (7.4%)		16 (5.6%)	42 (8.7%)		12 (7.4%)	13 (8.9%)	4 (4.7%)	
Healthy weight	345 (44.5%)	61 (43.0%)	225 (46.6%)		111 (39.1%)	230 (47.6%)		78 (48.2%)	62 (42.5%)	36 (42.4%)	
Overweight	372 (47.9%)	69 (48.6%)	222 (46.0%)		157 (55.3%)	211 (43.7%)		72 (44.4%)	71 (48.6%)	45 (52.9%)	
Diabetes, yes, n (%)	215 (23.5%)	41 (24.3%)	133 (23.5%)	0.829	90 (25.6%)	121 (21.8%)	0.183	37 (21.0%)	45 (25.6%)	19 (21.8%)	0.574

Sample size is less than n_{max} due to missing values in some independent variables: Employment status ($n=5$); Income perception ($n=12$); Number of private sector appointments ($n=6$); Number of public sector appointments ($n=7$); Smoking habits ($n=10$); BMI ($n=139$)

BMI Body mass index, *NUTS II* Nomenclature of Territorial Units for Statistical purposes

[a] *p*-values for non-parametric independency tests (Chi-squared for categorical variables, Kruskal–Wallis for continuous variables)

In terms of socio-economic characteristics, education level showed significant associations with some oral health indicators, as the majority of those with four years of education or less had poorer oral hygiene frequency ($n=293$, 83.5%, $p<0.001$) and had extraction as last dental procedure ($n=143$, 81.2%, $p<0.001$). In addition, the income perception variables also showed significant associations with prosthetic needs ($p=0.030$) and last dental procedure ($p<0.001$), with those "living comfortably" with their income having fewer prosthetic needs ($n=77$, 13.6%) and more routine appointments ($n=34$, 19.3%). Participants who had a higher mean of attendance at private sector appointments had better oral health outcomes in terms of prosthetic needs (no need) (mean = 1.41 ± 3.11, $p=0.09$), oral hygiene frequency (brushing ≥ 2x/day) (mean = 1.52 ± 3.18, $p<0.001$) and last dental procedure (routine) (mean = 2.03 ± 3.18, $p<0.001$) compared with the ones with higher mean of attendance at public sector appointments (Table 1).

When considering general health-related characteristics, smoking habits were associated with the need for prosthetic treatment ($p=0.023$). BMI was significantly associated with oral hygiene frequency ($p=0.006$), with overweight individuals having less oral hygiene frequency ($n=157$, 55.3%) (Table 1).

Association between education level and oral health

Participants with 5–9 years of education had lower odds of needing prosthetic treatment than those with less education (≤ 4 years) (model 2, OR = 0.47; 95% CI: 0.26–0.85). Although not significant, the association was also negative for years of education ≥ 10 (model 2, OR = 0.71; 95% CI: 0.38–1.32).

Participants with more years of education (≥ 10 years) were less likely to brush their teeth < 2x/day (model 1, OR = 0.25; 95% CI: 0.14–0.43), even after further adjustment for smoking habits and BMI (model 2, OR = 0.31; 95% CI: 0.18–0.55). Considering model 2, participants ≥ 10 years of education were 3.23 times more likely (1/0.31) to brush their teeth ≥ 2x/day than those with ≤ 4 years of education. These participants were also more likely to have routine appointments (model 2, RRR = 5.96; 95% CI: 2.74–12.99) or other appointments (model 2, RRR = 4.25; 95% CI: 1.72–10.49), compared with tooth extraction as their last dental procedure (Table 2).

Association between income perception and oral health

Participants with a higher perceived income ("living comfortably with the present income") were less likely to need a prosthetic treatment (model 2, OR = 0.29; 95% CI: 0.13–0.62), less likely to brush < 2x/day (model 2, OR = 0.46; 95% CI: 0.25–0.86), and were also more likely to have had a routine appointment rather than an extraction as their last dental procedure (model 1, RRR = 5.55; 95% CI: 2.22–13.85), compared with those living with severe difficulties (Table 3).

Association between number of private sector appointments and oral health

We found an association between the number of private sector appointments and the need for prosthetic

Table 2 Association between the education level and oral health

		Education level		
		OR (95% CI)		
	n	≤ 4 years	5–9 years	≥ 10 years
Prosthetic need				
Model 1	736	Ref	0.45 (0.26–0.79)	0.67 (0.37–1.21)
Model 2	625	Ref	0.47 (0.26–0.85)	0.71 (0.38–1.32)
Brushing < 2x/day				
Model 1	906	Ref	0.46 (0.30–0.70)	0.25 (0.14–0.43)
Model 2	767	Ref	0.49 (0.31–0.76)	0.31 (0.18–0.55)
		RRR (95% CI)		
Last dental procedure				
Model 1	439			
Tooth extraction – Ref		-	-	-
Routine		Ref	1.88 (1.04–3.40)	5.96 (2.74–12.99)
Other treatments		Ref	2.25 (1.14–4.43)	4.25 (1.72–10.49)

Model 1 adjusted for sex and age. Model 2 further adjusted for smoking habits and BMI

≤ 4 years considered as the reference group

OR Odds Ratio, *RRR* Relative Risk Ratio, *Ref* Reference

Table 3 Association between the income perception and oral health

		OR (95% CI)			
		Perception with the present income			
	n	Very difficult to live	Difficult to live	Living	Living comfortably
Prosthetic need					
Model 1	727	Ref	0.68 (0.41–1.12)	0.50 (0.30–0.83)	0.30 (0.14–0.62)
Model 2	619	Ref	0.58 (0.33–1.04)	0.48 (0.27–0.83)	0.29 (0.13–0.62)
Brushing < 2x/day					
Model 1	766	Ref	0.97 (0.63–1.49)	0.67 (0.44–1.02)	0.50 (0.29–0.88)
Model 2	760	Ref	0.80 (0.49–1.32)	0.54 (0.33–0.87)	0.46 (0.25–0.86)
		RRR (95% CI)			
Last dental procedure					
Model 1	435				
Tooth extraction – Ref		Ref	-	-	-
Routine		Ref	0.78 (0.36–1.72)	2.94 (1.26–5.94)	5.55 (2.22–13.85)
Other treatments		Ref	1.62 (0.70–3.76)	1.33 (0.57–3.06)	2.77 (0.92–8.27)

Model 1 adjusted for sex and age. Model 2 further adjusted for smoking habits and BMI

"Very difficult to live with the present income" considered as the reference group

OR Odds Ratio, *RRR* Relative Risk Ratio, *Ref* Reference

treatment (model 1, OR = 0.90; 95% CI: 0.82–0.99), the odds of brushing their teeth < 2x/day (model 2, OR = 0.92; 95% CI: 0.86–0.98) and a positive association concerning the risk of having routine appointments (model 1, RRR = 1.19; 95% CI: 1.07–1.32) and other treatments compared with extractions (model 1, RRR = 1.17; 95% CI: 1.04–1.31) (Table 4).

Discussion

As far as we know, this is the first study carried out in Portugal to assess oral health inequalities focusing on older adults. Our findings support the hypothesis that socio-economic factors, specifically education level, income perception and number of private sector appointments, are risk factors for oral health in the ageing population. We also found an association between geographical area of residence and oral health outcomes. Finally, general health characteristics, such as smoking habits and BMI, were associated with oral health indicators.

The literature has shown that the analysis of indicators, such as educational level, employment status and income, are important in assessing the socio-economic status of the population, covering different aspects of social stratification. Thus, the association of socio-economic and demographic characteristics with oral health indicators allows the identification of relevant risk factors influencing access to oral health services [11, 14, 16]. Furthermore, socio-economic inequalities in oral health represent a major challenge for health policies, as reducing the burden of access to oral health care in disadvantaged groups offers great potential for improving the oral health status of the population [14, 17].

Concerning education level, most of the participants in this study had a low level of education (4 years or less). It

Table 4 Association between the number of private sector appointments and oral health

		Number of private sector appointments		
	n	Model 1 OR (95% CI)	*n*	Model 2 OR (95% CI)
Prosthetic need	629	0.90 (0.82–0.99)	534	0.92 (0.94–1.01)
Brushing < 2x/day	772	0.90 (0.83–0.96)	653	0.92 (0.86–0.98)
		Model 1 RRR (95% CI)		**Model 2 RRR (95% CI)**
Last dental procedure	384			
Tooth extraction – Ref		-		-
Routine		1.19 (1.07–1.32)		-
Other treatments		1.17 (1.04–1.31)		-

Model 1 adjusted for sex and age. Model 2 further adjusted for smoking habits and BMI

OR Odds Ratio, *RRR* Relative Risk Ratio, *Ref* Reference

is important to note that Portugal had a dictatorship that lasted 48 years, ending in 1974. At that time, compulsory education was 3 years for women and 4 years for men. In addition, most families had to choose between sending their children to work to contribute to the household income or to study. Only the most privileged had access to higher education. This historical fact may explain why most of the participants analyzed had four years of education or less [16, 26]. In this sense, a lower level of education is associated with greater misunderstanding of health communication and, consequently, poor perception of and compliance with health care, which affects the overall health status and leads to an increased risk of oral problems, as we can confirm by our results [11, 13, 14]. However, these findings contrast with those of Andrade et al. (2020), who found no significant association between educational level and the use of dental services in Portugal [14]. Nevertheless, we cannot compare our results with this study because we assessed the reason for the last dental visit and not the use of oral health services.

The reason for the last dental visit was mainly routine for participants with higher levels of education. The level of literacy determines the personal awareness of seeking oral health care, the need for routine dental services and the knowledge of the best practices for oral diseases prevention, leading to a lower prevalence of oral conditions, such as dental caries, tooth loss and edentulism. In addition, education influences income level, which increases the likelihood of seeking oral health care in the private sector [11, 14, 27, 28].

As mentioned above, most of the dental care services in Portugal are provided by the private sector. Although there are agreements between private clinics and health insurance companies, part of the amount is still paid by the patient. Therefore, the Portuguese Oral Health Programme was launched in 2005 as a major public health initiative to reduce inequalities. In 2008, this programme introduced dental vouchers for children, adolescents, pregnant women, elderly people with low socio-economic status, and patients with human immunodeficiency virus, or suspected oral cancer. These vouchers provide free access to a range of dental services, including preventive care, restorations, endodontic treatment, and extractions. The number of vouchers varies by group, for example, the elderly have access to two vouchers per year for dental appointments [16, 17, 29]. On the other hand, the financial crisis of 2007–2008 limited access to private oral health services, although attempts have been made to integrate dentists into the National Health System. Notwithstanding, the number of affiliated health centers where dentists can work remains low, further limiting access to dental care, with notoriously long waiting lists. This means that only some older adults have access to more affordable oral health care and inequalities in access to oral health persist [16, 29, 30].

Consistent with other studies, we found that a higher mean of private sector appointments was more likely to be associated with having edentulous areas rehabilitated with prosthetic treatment, having better oral hygiene frequency and routine at the last dental visit, as a consequence of easier access to the private sector for those with higher socio-economic status [16, 17, 30, 31].

The mean age of the participants of this study was 74.3 years, and the majority were female, which is in line with other studies in Portugal and is explained by the higher life expectancy of the female sex [2, 23]. Although older women tend to report poorer oral health outcomes [32], in this study, we found that women were more likely to have better oral health indicators, which has been often linked to their greater health perception of the impact of oral health on their quality of life and adherence to preventive health behaviours [23]. Therefore, this may indicate that these behaviours may not be sufficient to fully address other factors influencing their reporting of oral health status, such as oral health literacy [33].

Consistent with other reports, the mean age was higher in participants with less frequent oral hygiene. This result may be explained by the fact that older participants may find it more difficult to maintain their oral hygiene frequency, as cognitive and functional impairment tends to increase with age. The mean age was also higher for those who had a tooth extraction as their last dental procedure, suggesting that the increased difficulty in mobility associated with ageing may also be a factor in older adults attending more appointments for tooth extraction or urgent problems and fewer routine appointments as they get older [23, 34, 35].

Our findings suggested that participants from Lisbon, which is the capital of Portugal and a predominantly urban area, also had a better oral hygiene frequency, compared to other regions of the country. This result is supported by the literature, as several studies show that rural areas have fewer preventive practices, while urban areas have more health capital, resulting in better access to health care and higher levels of education and, consequently, literacy [8, 23, 35]. Furthermore, loneliness and isolation are problems associated with the older population living in rural areas and it has also been reported an association between social isolation and the presence of fewer teeth in the mouth and non-rehabilitated edentulous patients, probably because of the importance of facial expression and the mouth in conveying emotions [23, 35].

In line with other studies, our results confirm the existence of an association between smoking habits and BMI and oral health indicators, as smoking and obesity are risk factors already linked to poor oral health and oral

diseases, such as periodontal disease and dental caries [8, 36–39]. In addition, BMI has been associated with oral hygiene, which supports the findings of our study [36].

However, we did not find an association between any of the oral health indicators and diabetes, probably because this chronic disease is more closely associated with periodontal disease, which may be a consequence of poor oral health behaviours, although it has a multifactorial etiology [3, 5, 8].

Our results should be analyzed with caution, as some limitations should be mentioned. This study did not include other indicators of oral health and it is possible that important dimensions of socio-economic inequalities were not present. We recommend that future studies on this subject include other indicators, such as self-reported number of teeth, the reason for tooth extraction at last dental procedure, other oral hygiene behaviours (e.g., interproximal cleaning), self-perceived oral health, or clinical indicators. The inclusion of new variables would help to explore and define which are the factors that need more attention among Portuguese older adults, allowing the development of oral health programmes to help improve literacy in this age group.

It is also important to note that due to the cross-sectional design of the study, it is not possible to establish causal relationships between socio-economic data and oral health outcomes. In addition, the use of relatively old data may also be a limitation of this work. However, since the time of the survey, there is no evidence of relevant changes in the oral health indicators of Portuguese older adults or in policies aimed at changing the behaviour of this population. Furthermore, to the best of our knowledge, there are no more recent studies in Portugal on this subject or with such a large sample covering different geographical areas of the country. Therefore, we believe that our findings are relevant to the current Portuguese context.

Conclusions

Based on our findings, we conclude that lower levels of education, perceived lower income and lower attendance at private sector appointments are factors that are more likely to lead to poor oral health in Portugal. Other factors found to be associated with oral health were sex, age, geographical area, smoking habits, and body mass index.

As a final remark, the results of this retrospective study have allowed the identification of some target groups that need higher literacy of specific preventive measures and better access to oral health services. Our study intends to contribute to future national public health strategies for the prevention of oral diseases and the expansion of oral health services to ensure better coverage of older adults.

Abbreviations

BMI	Body mass index
CI	Confidence interval
EpiDoC	Epidemiology of chronic diseases cohort study
NUTS II	Nomenclature of Territorial Units for Statistical purposes, *Nomenclatura das Unidades Territoriais para Fins Estatísticos*
OR	Odds ratio
Ref	Reference
RRR	Relative risk ratio

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Authors' contributions

ICS, HC, ACM and MP designed the study. ICS and DGL performed the analyses. ICS, GDC and DGL drafted the manuscript. JJM, MP, ACM and HC critically revised the manuscript. All authors read and approved the final version of the manuscript.

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Data availability

The data underlying this article were provided with permission from the EpiDoC Unit of NOVA Medical School. The datasets analyzed in the current study are available from the corresponding author on reasonable request, with the permission of the group leaders of the EpiDoc Unit.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the tenets of the Declaration of Helsinki, as revised in Fortaleza in 2013. The EpiDoC study was approved by the Ethics Committee of the NOVA Medical School and the Portuguese Data Protection Authority (Comissão Nacional de Proteção de Dados). Details of the ethical aspects of the EpiDoC study have been described in a previous report [20]. The secondary analysis of the present study was approved by the Ethics Committee of the NOVA Medical School (n.79/2020/CEFCM). All participants provided written informed consent for all phases of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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